

**REMARKS**

Claims 1-14 are presently pending in the application.

Claims 15-20 have been cancelled in view of the finality of the Restriction Requirement and without prejudice to the filing of a Divisional application directed to the subject matter thereof.

Claim 5 has been amended to correct a spelling error.

Claims 9-11 have been amended to correct an obvious typographical error. The chemical formulas have been amended to refer to HCl (hydrochloric acid) rather than HCI (not a recognized chemical compound). This amendment is supported, for example, by paragraph [014] of the specification. Accordingly, no new matter has been added and entry of the amendments is respectfully requested.

The Examiner acknowledges the election made on January 8, 2007 of group I (claims 1-14) and the specie of composition of the first cleaning solution recited in claim 7, as specified by Applicants in the Response to Restriction and Election of Species Requirement dated January 8, 2007.

In the Office Action of November 11, 2006, the Examiner indicated that group I contained claims directed to the following patentably distinct species:

1. The specie of the first cleaning solution comprising a  $\text{H}_2\text{O}:\text{H}_2\text{O}_2:\text{NH}_4\text{OH}$  solution, as exemplified by claim 7
2. The specie of the first cleaning solution comprising a  $\text{H}_2\text{O}:\text{H}_2\text{O}_2:\text{HCl}$  solution, as exemplified by claim 9

However, the Examiner did not include the specie of the first cleaning solution comprising a  $\text{HF}:\text{HCl}:\text{H}_2\text{O}$  solution, as exemplified by claim 11. On November 14, 2006, and again on March 16, 2007, the Examiner acknowledged by telephone that the specie of claim 11 should have also been included. Claims 9-11 continue to be maintained in the present

application, since they are directed to non-elected species, which may be allowed if the genus claim is allowed.

Objections to the Specification

The Examiner has objected to the disclosure. The Examiner contends that it is unclear which SC1 cleaning solution Applicants regard as standard, because paragraph [0013] discloses “cleaning the semiconductor wafer using a 5:1:1 H<sub>2</sub>O:H<sub>2</sub>O<sub>2</sub>:NH<sub>4</sub>OH solution,” which is described in paragraph [0007] as a standard SC1 cleaning solution, while paragraph [0031] discloses the use of a “standard SC1 cleaning solution, wherein the proportions of H<sub>2</sub>O:H<sub>2</sub>O<sub>2</sub>:NH<sub>4</sub>OH fall in the range of 1:1-5:4-80.” The Examiner contends that the latter solution proportions are apparently not a standard SC1 cleaning solution.

In using the term “standard cleaning solution” with respect to the abbreviation “SC1,” Applicants are referring to the actual *chemical composition* of the solution *rather than the ratio* in which such chemicals are present in the solution. SC1 is an abbreviation for “Standard Clean 1,” and refers to a solution of ammonium hydroxide, hydrogen peroxide and deionized water. Applicants do not actually refer to a “standard SC1 cleaning solution”, as suggested by the Examiner, but rather refer to SC1 itself as a “standard cleaning solution.” The standard cleaning solution, SC1, may vary in the ratio of its components. Thus, any ratio of H<sub>2</sub>O:H<sub>2</sub>O<sub>2</sub>:NH<sub>4</sub>OH solution is considered an SC1 solution. For the Examiner’s convenience, Applicants have enclosed literature that defines SC1 and mentions different ratios of the solution. Withdrawal of this objection is therefore respectfully requested.

Rejections under 35 U.S.C. § 103(a)

The Examiner has rejected claims 1-8, 12, and 13 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Publication No. 2003/0045098 of Verhaverbeke et al. (“Verhaverbeke”) in view of U.S. Patent Application Publication No. 2006/0051920 of Yamaguchi et al. (“Yamaguchi”). The Examiner contends that Verhaverbeke discloses a semiconductor cleaning process comprising forming a gate structure, including polysilicon, wherein the steps of the cleaning include treatment with ozonated water, then treatment with the first cleaning solution that is NH<sub>4</sub>OH/ H<sub>2</sub>O<sub>2</sub> and water, then with the second cleaning solution as

described in Figs. 15A-15D, and paragraphs [0059] and [0210]. The Examiner contends the gate structure is formed by etching.

The Examiner acknowledges that Verhaverbeke differs from the instant claims by not specifically disclosing the sandwiched structure of the gate layer between two oxide layers. The Examiner contends, however, that Verhaverbeke provides a general teaching of the same polysilicon gate layer and one of the oxide layers. The Examiner further contends that it is well known in the art to form sandwiched layers of oxides having polysilicon layer in between, such as that disclosed in Yamaguchi. The Examiner concludes that it would have been obvious to those skilled in the art at the time of the invention to cover the polysilicon layer of Verhaverbeke with oxide, as suggested by Yamaguchi.

With regard to claims 7, 8, 12, and 13, the Examiner notes that the criticalities of such ratios recited are not disclosed, and the indicated ratios can be obtained by those skilled in the art via routine experimentation. The Examiner concludes that such optimization is (sic., would have been) obvious.

These rejections are respectfully traversed as follows. In supporting the rejection of claims 1-8, 12, and 13, the Examiner has relied upon Yamaguchi as a reference. However, this reference is an improper reference, as it does not constitute prior art with respect to this application. That is, U.S. application of Yamaguchi was filed on May, 24, 2005, which is subsequent to the December 10, 2003 filing date of the present application. In addition, the PCT application to which Yamaguchi claims priority was not published in English. Therefore, this §103(a) rejection is improper.

Furthermore, the presently claimed invention would not have been obvious over Verhaverbeke in view of Yamaguchi, even if Yamaguchi were a proper reference and the combination were proper, neither of which Applicants concede. Neither of these references teaches or suggests the step of cleaning the semiconductor wafer *including the gate structure* using ozonated de-ionized (DI) water.

In the presently claimed invention, several layers are formed on a semiconductor layer (first layer, floating gate layer, and second layer). The layers are then etched to form a gate

structure. After the gate structure has been formed, the semiconductor wafer, including the gate structure, is cleaned using DI water.

In contrast, Verhaverbeke teaches only a process of first cleaning a semiconductor and *subsequently* forming a gate structure. To illustrate, Verhaverbeke discloses an Integrated Clean/Gate tool. Verhaverbeke states that the tool can be used to clean a wafer and *then* form a high quality gate dielectric and gate electrode on a silicon monocrystalline substrate or epitaxial layer” (paragraph [0117]). The paragraphs following paragraph [0171] describe the process. In these paragraphs, Verhaverbeke discloses that a wafer comprising oxide formed on a doped monocrystalline silicon substrate (generally containing contaminants) is exposed to an etchant to etch the oxide. Directly after etching the oxide, the wafer is wet cleaned. Verhaverbeke discloses that the wafer may be cleaned by standard RCA cleaning solutions (SC1 and SC2) during this cleaning step. If the wafer has been sufficiently cleaned, then the wafer is further processed such that a gate structure is formed as described in Figs. 15B-15E. That is, a dielectric film is formed (paragraph [0180]), a polysilicon film is formed (paragraph [0205]), a gate electrode is etched, and source drain regions and spacers are formed (paragraph [0214]). Reconsideration and withdrawal of this § 103(a) rejection are therefore respectfully requested.

*Rejection of claim 14 under 35 U.S.C. § 103(a)*

The Examiner has rejected claim 14 under 35 U.S.C. 103(a) as being unpatentable over Verhaverbeke in view of Yamaguchi, in further view of U.S. Patent Application Publication No. 2003/0056806 of Lee et al. (“Lee”). The Examiner acknowledges that the combination of Verhaverbeke and Yamaguchi does not specify the second cleaning solution as containing deionized ozonated water. However, the Examiner contends that the combination does teach that the second cleaning solution comprises HF. The Examiner further contends that using ozonated water in combination with HF is conventional in semiconductor cleaning processes, such as that disclosed in Lee. The Examiner contends that Lee discloses a method of cleaning residue on semiconductor devices, including mixing HF and ozone water, and dipping a semiconductor device in a vessel containing the solution of HF and ozone water. The Examiner concludes that it would be (sic, would have been) obvious to those skilled in the art to add ozonated water to the HF of Verhaverbeke in order to enhance cleaning and better remove polymer residues.

In view of the above arguments regarding the improper use of Yamaguchi as a prior art reference and the failure of the combination of Verhaverbeke and Yamaguchi to teach or suggest the presently claimed invention, claim 14 is patentable for at least the same reasons described above with respect to claims 1-8, 12, and 13. Reconsideration and withdrawal of this rejection are therefore respectfully requested.

It is therefore respectfully submitted that all of the pending claims in the application patentably distinguish over the prior art of record. Reconsideration and a Notice of Allowance are therefore respectfully requested.

Respectfully submitted,

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(Date)

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Enclosures: Petition for Extension of Time (one-month)  
Surface Cleaning and Wet Processing Terminology, University of Arizona 1999